

Final Report

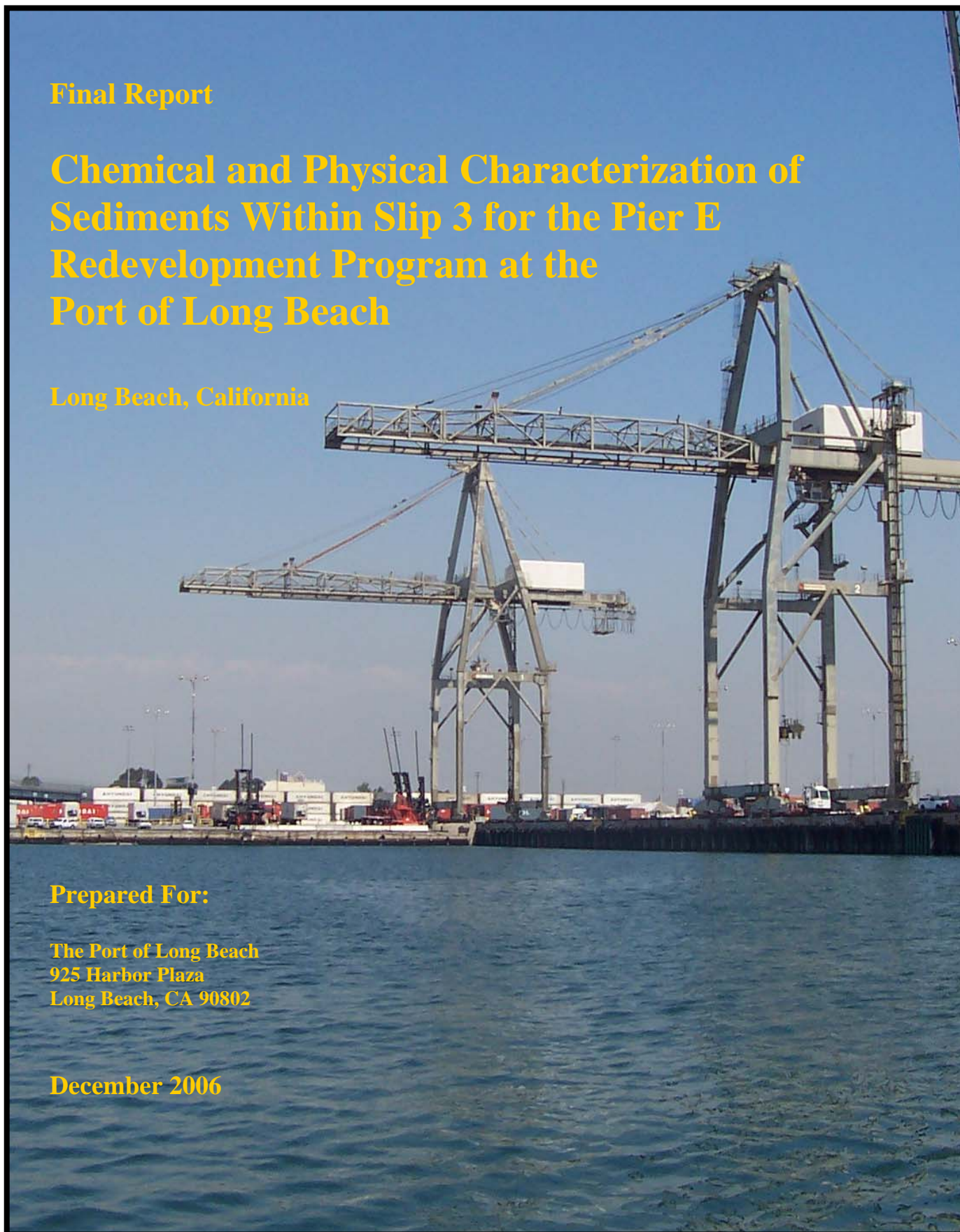
Chemical and Physical Characterization of Sediments Within Slip 3 for the Pier E Redevelopment Program at the Port of Long Beach

Long Beach, California

Prepared For:

**The Port of Long Beach
925 Harbor Plaza
Long Beach, CA 90802**

December 2006



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ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
COC	chain of custody
CVAFS	cold vapor atomic fluorescence spectrophotometry
DGPS	Differential Global Positioning System
DRET	dredged elutriate test
ER-L	effects range - low
ER-M	effects range - median
GC-MS	gas chromatography-mass spectrometry
HMW	high molecular weight
ICP-MS	inductively coupled plasma – mass spectrometry
ID	identification
LMW	low molecular weight
MLLW	mean lower low water
MDL	method detection limit
MRL	method reporting limit
n/a	not applicable
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	probable effect level
POLB	Port of Long Beach
QA/QC	quality assurance/quality control
RIA	Regional Implementation Agreement
SAP	sampling and analysis plan
SIM	selective ion monitoring
SM	Standard Methods
SOP	standard operating procedure
SVOC	semivolatile organic compounds
TOC	total organic carbon
TRPH	total recoverable petroleum hydrocarbon
TSS	total suspended solids
TTLc	total threshold limit concentration
USACE	United States Army Corps of Engineers
USACE-LA	United States Army Corps of Engineers, Los Angeles District
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
WAAS	Wide Area Augmentation System
Weston	Weston Solutions, Inc.

UNITS OF MEASURE

cy	cubic yards
°C	centigrade
ft	feet or foot
g/cc	gram per cubic centimeter
L	liter
mg/kg	milligram per kilogram
µg/L	microgram per liter
µg/kg	microgram per kilogram
ng/L	nanogram per liter

1.0 INTRODUCTION

1.1 Background

The Port of Long Beach (POLB) proposes to conduct dredging in Slip 3 as part of their Pier E Redevelopment Program in POLB, Long Beach, California. Current plans involve dredging the existing depths ranging from -36 to -54 feet Mean Lower Low Water (ft MLLW) to a depth of -55 ft MLLW. The project area lies between Piers D and E and is approximately 4500 ft northeast of the Outer Harbor opening. Slip 3 extends from North to South and is approximately 2100 ft in length, and approximately 350 ft across. The dredge footprint consists of two sampling areas (Area PE 1 and Area PE 2), each containing six different sediment core locations, respectively (Figure 1). The proposed project consists of dredging approximately 110,667 cubic yards (cy) of material from Area PE 1 and 105,271 cy from Area PE 2, to a design depth of -55 ft MLLW, for a total dredged material volume of 215,938 cy (Table 1). With a two foot over-dredge allowance, the potential dredged material to be removed is approximately 143,097 cy of material from Area PE 1 and 140,026 cy from Area PE 2, for a total dredged material volume of 283,123 cy at a depth of -57 ft MLLW. As part of the Pier E Redevelopment Program, POLB proposes to use the dredged material from Slip 3 as fill in Slip 1.

Prior to disposal, it was necessary to evaluate dredged material from Slip 3 for its potential suitability for use as fill material in Slip 1. The material sampled from Slip 3 was evaluated based on applicable criteria outlined in the Regional Implementation Agreement (RIA) (United States Environmental Protection Agency [USEPA] Region IX / United States Army Corps of Engineers, Los Angeles District [USACE-LA] 1993) and Title 22 of the California Code of Regulations for the classification for hazardous material.

Table 1. Proposed Dredge Volume for Material to be Removed from Areas PE 1 and PE 2 Within Slip 3, Port of Long Beach

Area	Dredge Volume (cy) (-55 ft)	Dredge Volume (cy) (-55 ft + 2 ft overdredge)
PE 1	110,667	143,097
PE 2	105,271	140,026
Total	215,938	283,123

1.2 Objective

The objective of this investigation was to evaluate the chemical characteristics of sediment and sediment elutriates from Slip 3, found between Piers D and E in POLB, to determine acceptability of the material for use as fill material in Slip 1. As part of this study, the geotechnical properties of sediment were also evaluated.

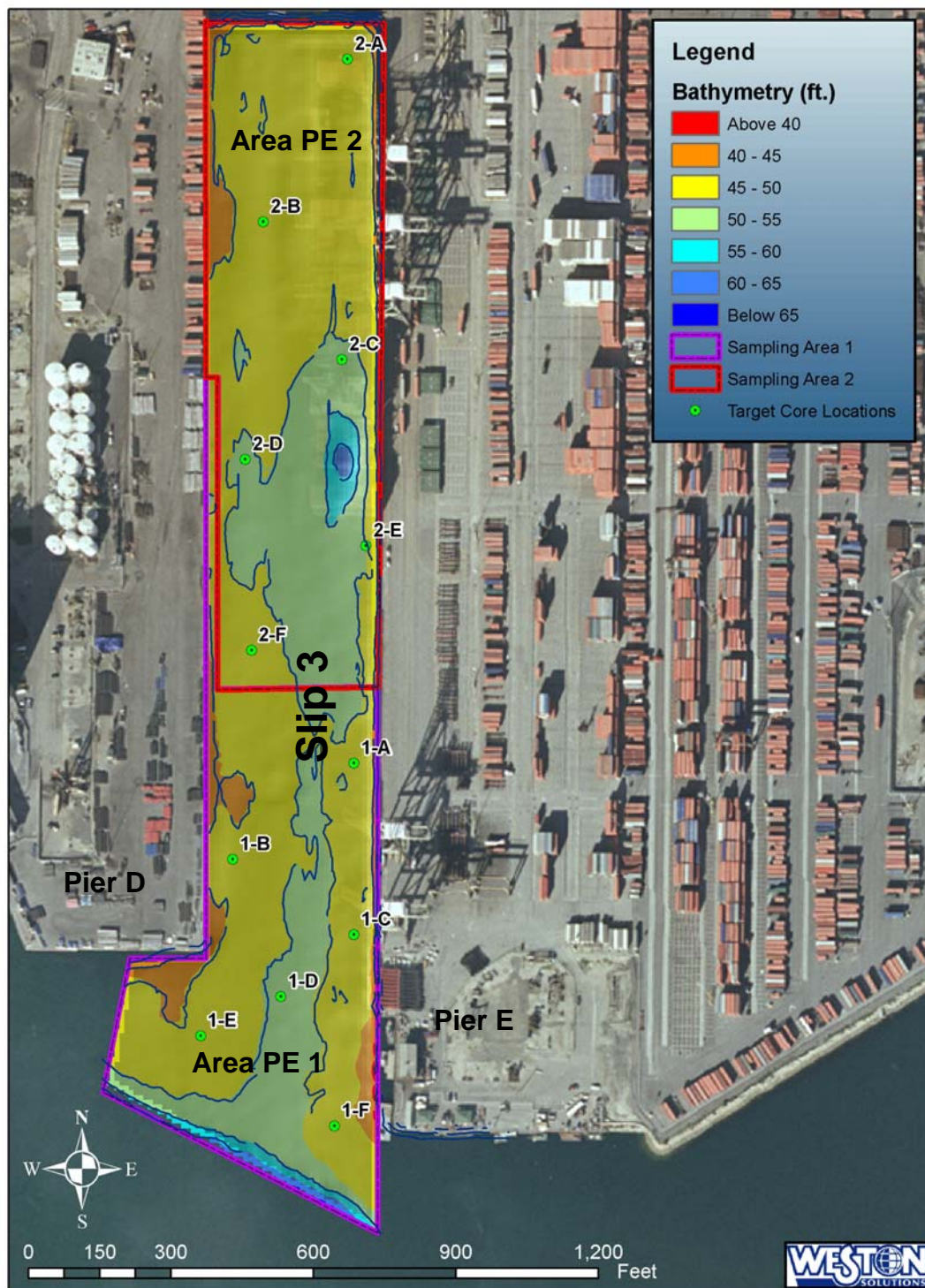


Figure 1. Sampling Locations Within Slip 3 of the Port of Long Beach

2.0 MATERIALS AND METHODS

2.1 Field Collection Program for Sediment Core Samples

2.1.1 Sampling Locations and Depths

Vibracore sampling was conducted September 11-13, 2006. The weather was foggy, with light winds and calm seas in the mornings and sunny with moderate winds and mildly choppy seas in the afternoons.

Vibracore sampling was conducted at 12 locations within the proposed dredging footprint in Slip 3 within POLB. The locations were positioned within two separate areas (PE 1 and PE 2), with 6 locations (A through F) within each area (Figure 1). The number of cores, core identification (ID) numbers, locations, and target lengths are provided in Table 2.

Table 2. Core Locations, Target Lengths, Number of Cores, Composite ID, and Analyses for Samples Collected by Vibracore.

Core ID	Latitude (WGS 84)	Longitude (WGS 84)	Existing Water Depth (feet MLLW)	Dredge Depth (feet MLLW)	Project Depth (Dredge Depth + 2 feet)	Sampling Depth (Dredge Depth + 5 feet)	Target Core Length (feet)	Composite ID	Composite Analyses
PE 1-A	33°45.500'	-118°12.839'	48.5	55.0	57.0	60.0	11.5	PE 1	Chemical, Physical
PE 1-B	33°45.470'	-118°12.898'	46.3	55.0	57.0	60.0	13.7		
PE 1-C	33°45.445'	-118°12.841'	49.3	55.0	57.0	60.0	10.7		
PE 1-D	33°45.423'	-118°12.876'	51.4	55.0	57.0	60.0	8.6		
PE 1-E	33°45.410'	-118°12.911'	46.3	55.0	57.0	60.0	13.7		
PE 1-F	33°45.378'	-118°12.854'	47.7	55.0	57.0	60.0	12.3		
PE 2-A	33°45.753'	-118°12.842'	47.2	55.0	57.0	60.0	12.8	PE 2	Chemical, Physical
PE 2-B	33°45.689'	-118°12.879'	46.2	55.0	57.0	60.0	13.8		
PE 2-C	33°45.639'	-118°12.843'	51.5	55.0	57.0	60.0	8.5		
PE 2-D	33°45.612'	-118°12.888'	49.7	55.0	57.0	60.0	10.3		
PE 2-E	33°45.579'	-118°12.838'	48.2	55.0	57.0	60.0	11.8		
PE 2-F	33°45.547'	-118°12.884'	48.5	55.0	57.0	60.0	11.5		

2.1.2 Navigation

Pre-plotted station positions were located using the research vessel *Early Bird II's* Differential Global Positioning System (DGPS) or a Wide Area Augmentation System (WAAS) handheld Garmin eTrex GPS. The DGPS uses U.S. Coast Guard differential correction data, and are accurate to less than 10 ft.

2.1.3 Core Collection and Description

Cores were collected using an electric vibracore (Figure 2) in all areas accessible by the *Early Bird II*. The vibracore was equipped with a 4-inch outer diameter aluminum barrel and stainless steel cutter head. The standard system is capable of collecting cores up to ~20 ft long, which was more than sufficient to cover the target sampling depths identified in this project. All sediment cores were collected to the appropriate depth unless refusal is encountered. Refusal is defined as less than 2 inches of penetration per minute.

Each vibracore sample was brought to the vessel platform, where the sediment sample was extruded from the core barrel onto polyethylene-lined collection trays. Then each core was examined by a qualified scientist and photographed. The geologic description of each core included the texture, odor, color, and length.

2.1.4 Site Water

In addition to the vibracore samples, site water was collected from Slip 3 for chemical analysis and for use in the preparation of sediment elutriates as described in Section 2.2.4.

2.1.5 Decontamination of Equipment

All vibracore equipment was cleaned prior to sampling. Between stations, core barrels and the deck of the vessel were rinsed with site water. Plastic liners were rinsed between sample locations within an area and a new plastic liner was used for each area. Before creating each composite, all stainless steel utensils (stainless steel bowls, spoons, spatulas, mixers, and other utensils) were cleaned with soapy water, rinsed with tap water, and then rinsed three times with deionized water.

2.1.6 Sample Processing and Storage

Sediment cores from each sampling location were examined for stratification and were split into top and bottom layers based on stratigraphy. Top and bottom core samples were separately composited from areas PE 1-A to PE 1-F for chemical and physical analyses, and top and bottom core samples were separately composited from areas PE 2-A to 2-F, for a total of four composite samples (i.e., Area PE 1 top, Area PE 1 bottom, Area PE 2 top, and Area PE 2 bottom). Each composite was homogenized in a stainless steel bowl with stainless steel utensils. Material was placed in glass jars with Teflon lined-lids; 500 mL of material was archived at Weston Solutions, Inc. (Weston) in Carlsbad, California, 500 mL was analyzed for chemical constituents at CRG Marine Laboratories, 500 mL was analyzed for Atterberg limits and TOC at Applied Marine Sciences, and 500 mL was analyzed by Weston's Benthic Laboratory in Carlsbad for grain size and specific gravity. In addition, 2 L of each composite, and 40 L of site water was submitted to CRG Marine Laboratories (CRG) to prepare sediment elutriates for chemical analyses. Site water (2 L) was also submitted to CRG for chemical analysis.

Samples were labeled, placed on ice, and shielded from light until delivered to CRG or Weston laboratory personnel for analysis. Any sediment not immediately analyzed was stored at 4°C at the Weston's laboratory in Carlsbad until chemical and geotechnical characterization is complete.

2.1.7 Shipping

Prior to shipping, sample containers were placed in sealable plastic bags and securely packed inside the cooler with ice. Chain of custody (COC) forms were filled out as described in section 2.1.8, and the original signed COC forms were placed in a sealable plastic bag and placed inside the cooler. The cooler lids were securely taped shut. Samples were delivered to the analytical laboratories for analysis. The laboratories, particular analyses to be performed by each, and the point of contact and relevant shipping information for each laboratory are listed in Table 3.

Table 3. Analytical Laboratories, Points of Contact, and Shipping Information

Laboratory	Analyses Performed	Point of Contact	Shipping Information
Weston Solutions, Inc. Carlsbad, CA	Grain size, specific gravity	Dr. David Moore and Ms. Sheila Holt (760) 931-8081	Weston Solutions, Inc. 2433 Impala Dr. Carlsbad, CA 92010
CRG Marine Laboratories	Sediment, Elutriate, and Site Water Chemistry	Mr. Rich Gossett (310) 533-5190	CRG Marine Laboratories 2020 Del Amo Blvd., Suite 200 Torrance, CA 90501
Applied Marine Sciences	TOC and Atterberg analysis	Mr. Ken Davis (281) 554-7272	Applied Marine Sciences 502 N. Hwy 3, Suite B League City, TX 77573



Figure 2. Vibracore Sampler

2.1.8 Documentation and Chain-of-Custody

Samples were considered to be in custody if they were: (1) in the custodian's possession or view, (2) retained in a secured place (under lock) with restricted access, or (3) placed in a secured container. The principal documents used to identify samples and to document possession were COC records, field log books, and field tracking forms. COC procedures were used for all samples throughout the collection, transport, and analytical process, and for all data and data documentation, whether in hard copy or electronic format.

COC procedures were initiated during sample collection. A COC record was provided with each sample or sample group. An example of a COC form is provided in Appendix A. Each person who has custody of the samples signed the form and ensure that the samples were not left unattended unless properly secured. Minimum documentation of sample handling and custody included the following:

- Sample identification
- Sample collection date and time
- Any special notations on sample characteristics
- Initials of the person collecting the sample
- Date the sample was sent to the laboratory
- Shipping company and waybill information

The completed COC form was placed in a sealable plastic envelope within the ice chest containing the listed samples. The COC form was signed by the person transferring custody of the samples. The condition of the samples was recorded by the receiver.

2.2 Physical and Chemical Analyses

Physical and chemical analytes measured in this testing program were selected to provide data on potential chemicals of concern in POLB sediments. All analytical methods used to obtain contaminant concentrations follow USEPA, American Society for Testing and Materials (ASTM), or Standard Methods (SM). In addition, chemical and physical measures selected for this evaluation are consistent with those recommended for assessing dredged material in Los Angeles (USEPA/USACE 1991; USEPA Region IX/USACE-LA 1993). The specific sediment analyses and target detection limits are listed in the Weston's sampling and analysis plan (SAP; Weston 2006).

2.2.1 Physical Analyses

Physical analyses of the sediment included grain size, specific gravity, Atterberg limits and percent total solids. Grain size was analyzed to determine the general size classes that make up the sediment (e.g., gravel, sand, silt, and clay) using the gravimetric procedure described in Plumb (1981). The frequency distribution of the size ranges (reported in millimeters) of the sediment was also reported. Total solids were also measured to convert concentrations of the chemical analytes from a wet-weight to a dry-weight basis. Total solids were determined by SM 2540G (Clesceri et al. 2000). Atterberg limits were evaluated by ASTM D4318 (ASTM 2005) to measure the plasticity of the sample for unified soil classification system (USCS) designation.

2.2.2 General Chemistry

General chemistry included analysis of total organic carbon (TOC), sulfides, ammonia, oil and grease and total recoverable petroleum hydrocarbons (TRPH) in sediments. The TOC, made up of volatile and

nonvolatile organic compounds, was determined by Lloyd Kahn (1988), a modified USEPA 9060. This procedure involves dissolving inorganic carbon (carbonates and bicarbonates) with hydrochloric acid or sulfuric acid prior to TOC analysis. The analysis for total and dissolved sulfides followed SM 4500-S₂ D while the analysis for dissolved ammonia followed SM 4500-NH₃. Oil and grease were measured using USEPA 1664A and TRPH were measured by USEPA 418.1.

2.2.3 Sediment Chemistry

The analysis for priority pollutant metals (except mercury) was conducted using an inductively coupled plasma emissions spectrometer equipped with a mass detector (ICP-MS), in accordance with USEPA 6020M. Mercury analysis was conducted using cold vapor atomic fluorescence spectrophotometry (CVAFS) in accordance with USEPA 245.7m. Acid extractable compounds and semivolatile organic compounds (SVOC) including polynuclear aromatic hydrocarbons (PAHs), phthalates, and phenols, chlorinated pesticides, and polychlorinated biphenyls (PCBs), were analyzed using gas chromatography-mass spectrometry with selective ion monitoring (GC/MS SIM) according to USEPA 8270M. This method followed serial extraction with methylene chloride and alumina and gel permeation column cleanup procedures. PCBs were identified as Aroclors and individual congeners, separately. Tributyltin and its derivatives were analyzed by GC/MS according to Krone et al. (1989), following a cleanup procedure involving methylene chloride extraction and Grignard derivatization.

2.2.4 Sediment Elutriate Chemistry and Site Water Chemistry

Elutriate samples were prepared by using a dredged elutriate test (DRET) method, a modification of the standard elutriate test procedure, according to DiGiano et al. (1995). The DRET is designed to mimic the concentration of total suspended solids (TSS) at the point of dredging.

The analysis of metals, ammonia, PAHs, phenols, phthalates, PCBs, organotins, and organochlorine pesticides in sediment elutriates and site water samples were similar to methods described above.

2.2.5 Comparison of Results to ER-L and ER-M Values and Water Quality Objectives

Sediment chemical concentrations in this study were compared to effects range – low (ER-L) and effects range – median (ER-M) values (Long et al., 1995) and regulatory levels, or total threshold limit concentrations (TTLCs). The effects range values are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern, in conjunction with biological analyses. Briefly, these values were developed from a large data set where results of both benthic organism effects (e.g., toxicity tests, benthic assessments) and chemical concentrations were available for individual samples. To derive these guidelines, the chemical values for paired data demonstrating benthic impairment were sorted in according to ascending chemical concentration. The 10th percentile of this rank order distribution was identified as the ER-L and the 50th percentile as the ER-M. While these values are useful for identifying elevated sediment-associated contaminants, they should not be used to infer causality because of the inherent variability and uncertainty of the approach. The ER-L and ER-M sediment quality values are used in conjunction with bioassay testing and are included for comparative purposes only. TTLCs indicate the level above which material must be managed as hazardous waste upon removal, in accordance with the Title 40 CFR part 261 and Title 22 of the California Code of Regulations.

Elutriate and site water analyte results were compared to the California Ocean Plan's water quality objectives (State Water Resources Control Board, California Environmental Protection Agency [SWRCB, Cal/EPA] 2006).

2.3 Quality Assurance Procedures

Weston's quality assurance/quality control (QA/QC) staff performs periodic audits to ensure that test conditions, data collection, and test procedures are conducted in accordance with Weston Solutions' standard operating procedures (SOPs). Weston's SOPs have been audited and approved by an independent USEPA-approved laboratory and placed in the QA file as well as laboratory files.

2.3.1 Field Collection and Sample Handling

All relevant project and sample information and field measurements were recorded on customized water-proof core log data forms. A daily field log was maintained, and formal chain-of-custody procedures were followed and documented. The GPS system was verified daily by comparing accuracy with known landmarks. All sampling equipment was cleaned between sample stations. Samples were double-bagged, and both inner and outer bags labeled. Samples were held on ice until transport to Weston Solutions in Carlsbad, California. COC forms were prepared in the field during sediment collection by Weston Solutions personnel. Once sediments were composited, a new COC was prepared for the transfer of sediments for physical, chemical and biological analyses.

2.3.2 Chemical and Physical Analyses

Chemical analyses were performed using QC criteria specified in Methods for Chemical Analysis of Water and Wastes (USEPA 1983) and Test Methods for Evaluating Solid Waste (SW-846) (USEPA 2004a), in a California state-certified laboratory (California ELAP Certification #2261). Atterberg Limits and TOC analyses were performed in accordance with QA procedures outlined by EPA (USEPA 2004b), ASTM (2005), the 2006 Department of Defense Quality Systems Manual for Environmental Laboratories (Version 3; DoD 2006) and the 2003 National Environmental Laboratory Accreditation Conference Standard (NELAC 2004) in a Texas state-certified and nationally-accredited laboratory (NELAP Certificate #E87956). Grain size analyses performed by Weston were consistent with internal QC criteria. Performance objectives were evaluated via the use of standard reference materials or laboratory control samples, method blanks, surrogates, spiked samples, duplicate samples, and internal QC samples. Precision and accuracy objectives were established for method reporting limits (MRLs), spike recoveries, and duplicate analyses.

3.0 RESULTS

3.1 Sediment Sample Collection and Handling

Vibracore sampling was conducted September 11-13, 2006. The weather was warm and sampling was conducted primarily under clear skies with light winds and calm seas.

Field coordinates, depth of penetration relative to the mudline (i.e., the sediment surface), depth of recovery relative to the mudline, and core length retained for each station location are summarized in Table 4. Sediment cores demonstrated stratification in areas PE 1 and PE 2.

The actual length of the cores differs from the target lengths because of differences in the actual bathymetry and the historical bathymetry used to calculate target core lengths. Field core logs, core photos, and other associated documentation for the sampling effort are provided in Appendix B.

Table 4. Field Coordinates and Sampling Depths of Sediment Core Samples

Core ID	Attempt	Latitude (WGS84) Degrees, Dec. Minutes	Longitude (WGS84) Degrees, Dec. Minutes	MLLW (ft) = Water Depth - Tide	Penetration (ft)	Target Sampling Depth (ft MLLW)	Actual Sampling Depth (ft MLLW)	Core Length (ft)	Core Length Retained for Processing and Analysis (ft)	Comments
PE 1-A	1	33°45.500'	-118°12.839'	48.5	14.0	60.0	62.5	14.0	11.5	
PE 1-B	1	33°45.470'	-118°12.898'	46.3	15.0	60.0	61.3	15.0	13.7	
PE 1-C	1	33°45.445'	-118°12.841'	49.3	14.0	60.0	63.3	14.0	10.7	
PE 1-D	1	33°45.423'	-118°12.876'	51.4	10.0	60.0	61.4	9.5	8.6	
PE 1-E	1	33°45.410'	-118°12.911'	46.3	15.0	60.0	61.3	15.0	13.7	
PE 1-F	1	33°45.378'	-118°12.854'	47.7	14.0	60.0	61.7	13.5	12.3	
PE 2-A	1	33°45.753'	-118°12.842'	47.2	14.5	60.0	61.7	13.5	12.8	
PE 2-B	1	33°45.689'	-118°12.879'	46.2	15.0	60.0	61.2	14.5	13.8	
PE 2-C	1	33°45.639'	-118°12.843'	51.5	13.0	60.0	64.5	12.8	8.5	
PE 2-D	1	33°45.612'	-118°12.888'	49.7	12.0	60.0	61.7	7.0	0.0	Abundant mussel shells prevented further recovery
PE 2-D	2	33°45.612'	-118°12.888'	49.7	13.5	60.0	63.2	12.0	10.3	
PE 2-E	1	33°45.579'	-118°12.838'	48.2	13.5	60.0	61.7	12.8	11.8	
PE 2-F	1	33°45.547'	-118°12.884'	48.5	12.0	60.0	60.5	11.0	11.0	

3.2 Results of Physical and Chemical Analyses

3.2.1 Physical and Chemical Characteristics of Sediments in Slip 3

Results of physical and chemical analyses for project sediment composites are presented in Table 5. All results are expressed in dry weight unless otherwise indicated. Target detection limits are provided in the SAP (Weston 2006). The actual detection limits and raw data for the analyses are provided in Appendix C.

3.2.1.1 Area PE 1 Top Layer

The top layer of sediment from the Area PE 1 consisted of 86.1% fine-grained materials (57.8% silt, and 28.3% clay), and 13.9% coarse-grained materials (1.51% gravel and 12.4% sand). The sediment was classified as a lean clay (CL) with a plasticity index of 22. The TOC was measured at 1.08%, and specific gravity was 1.54. Total solids were measured at 69.1% and ammonia was measured at 61.2 mg/kg wet weight. Total sulfides and dissolved sulfides were measured at 149 and 1.09 mg/kg, respectively. Oil and grease and TRPH were not detected.

In the top layer of Area PE 1 sediment, metals including arsenic, copper, mercury, and nickel exceeded their ER-L values, but were below ER-M values and TTLC regulatory levels. Concentrations of heavy metals of concern ranged from 0.15 mg/kg for silver to 118 mg/kg for zinc. One Aroclor PCB (1254) was measured at 22 µg/kg and several PCB congeners were detected; however, all PCB congeners were measured at concentrations below method reporting limits and were below ER-L values. Total PCBs exceeded the ER-L value of 22.7 µg/kg but were below the ER-M value. The only organochlorine pesticides detected were the DDT derivatives 2,4'- and 4,4'-DDE, at concentrations of 2.80 µg/kg (estimated) and 14.6 µg/kg, respectively. The derivative 4,4'-DDE and total DDTs exceeded the ER-L values of 2.2 µg/kg and 1.6 µg/kg, respectively, but were below the ER-M values of 27 µg/kg, and 46.1 µg/kg, respectively. Dibutyltin and tributyltin were measured at concentrations of 7.6 µg/kg and 56.7 µg/kg, respectively (no ER-L or ER-M values available). Several PAHs were detected at concentrations below ER-L values; however, total low molecular weight (LMW) PAHs were measured above the ER-L value of 552 µg/kg, but below the ER-M value. PAH concentrations ranged from an estimated value of 1.3 µg/kg for biphenyl to 204 µg/kg for pyrene. No phenols were detected. Concentrations of phthalates ranged from below the detection limit (< 5 µg/kg) for dimethyl phthalate to 640 µg/kg for di-n-butyl phthalate.

3.2.1.2 Area PE 1 Bottom Layer

The bottom layer of sediment from Area PE 1 consisted of 52.6% fine-grained materials (42.1% silt, and 10.5% clay), and 47.5% coarse-grained materials (0.28% gravel and 47.2% sand). The sediment was classified as a non-plastic (NP), silty sand (SM). TOC was measured at 0.39%, and specific gravity was 1.76. Total solids were measured at 69.6% and ammonia was measured at 61.9 mg/kg wet weight. Total sulfides and dissolved sulfides were measured at 70.7 and 1.24 mg/kg, respectively. Oil and grease and TRPH were not detected.

In the bottom layer of PE 1 sediment, concentrations of all metals were below ER-L values. Concentrations of heavy metals of concern ranged from 0.13 mg/kg for silver to 69.6 mg/kg for zinc. Several PCB congeners were detected; however, all PCBs were measured at concentrations below method reporting limits and were below ER-L values. Several PAHs were detected but were at concentrations below ER-L levels. PAH concentrations ranged from below detection limits for 1-methylnaphthalene to 38.6 µg/kg for pyrene. No organochlorine pesticides, organotins, or phenols were detected.

Concentrations of phthalates ranged from below the detection limit ($< 5 \mu\text{g/kg}$) for dimethyl phthalate to $790 \mu\text{g/kg}$ for di-n-butyl phthalate.

3.2.1.3 Area PE 2 Top Layer

The top layer of sediment from Area PE 2 consisted of 60.6% fine-grained materials (40.5% silt, and 20.1% clay), and 39.4% coarse-grained materials (06.56 % gravel and 32.8% sand). The sediment was classified as a lean clay (CL) with a plasticity index of 18. The TOC was measured at 1.51%, and specific gravity was 1.70. Total solids were measured at 66.3% and ammonia was measured at 41.7 mg/kg wet weight. Total sulfides and dissolved sulfides were measured at 177 and 0.67 mg/kg, respectively. Oil and grease and TRPH were not detected.

In the top layer of PE 2 sediment, metals including arsenic, copper, mercury, and nickel exceeded their ER-L values, but were below ER-M values. Concentrations of heavy metals of concern ranged from 0.13 mg/kg for silver to 110 mg/kg for zinc. One Aroclor PCB (1254) and several PCB congeners were detected; however, all PCB congeners except PCB138 and PCB153 were measured at concentrations below method reporting limits. Total PCBs exceeded the ER-L value of $22.7 \mu\text{g/kg}$ but were below the ER-M value. The only organochlorine pesticides detected were DDT derivatives (2,4'- and 4,4'-DDE, and 4,4'-DDD) and concentrations ranged from $2.30 \mu\text{g/kg}$ (estimated) for 4,4'-DDD to $15 \mu\text{g/kg}$ for 4,4'-DDE. The derivative 4,4'-DDE and total DDTs exceeded the ER-L values of $2.2 \mu\text{g/kg}$ and $1.6 \mu\text{g/kg}$, respectively, but were below the ER-M values of $27 \mu\text{g/kg}$, and $46.1 \mu\text{g/kg}$, respectively. The organotins dibutyltin and tributyltin were measured at concentrations of 8.6 and $59.5 \mu\text{g/kg}$, respectively. Several PAHs were detected at concentrations that exceeded the ER-L values including acenaphthene, anthracene, benz[a]anthracene, benzo[a]pyrene, chrysene, and dibenz[a,h]anthracene and concentrations of total LMW PAHs exceeded their ER-L value of $552 \mu\text{g/kg}$. All PAH concentrations were below ER-M values. PAH concentrations ranged from an estimated value of $3.8 \mu\text{g/kg}$ for biphenyl to $504 \mu\text{g/kg}$ for chrysene. No phenols were detected. Concentrations of phthalates ranged from below the detection limit ($< 5 \mu\text{g/kg}$) for dimethyl phthalate to $737 \mu\text{g/kg}$ for di-n-butyl phthalate.

3.2.1.4 Area PE 2 Bottom Layer

The bottom layer of sediment from Area PE 2 consisted of 33.3% fine-grained materials (27.4% silt, and 5.91% clay), and 66.7% coarse-grained materials (0.003% gravel and 66.7% sand). The sediment was classified as a non-plastic (NP), silty sand (SM). TOC was measured at 0.38%, and specific gravity was 1.82. Total solids were measured at 74.6% and ammonia was measured at 35.4 mg/kg wet weight. Total sulfides and dissolved sulfides were measured at 3.55 and 1.72 mg/kg, respectively. Oil and grease and TRPH were not detected.

In the bottom layer of PE 2 sediment, concentrations of all metals were below ER-L values. Concentrations of heavy metals of concern ranged from below detection limits for selenium and silver ($< 0.025 \text{ mg/kg}$) to 45.1 mg/kg for zinc. Several PAHs were detected at concentrations below ER-L values. PAH concentrations ranged from below detection limits for 1-methylnaphthalene to $18.9 \mu\text{g/kg}$ for benzo(a)pyrene. No organochlorine pesticides, PCBs, organotins, or phenols were detected. Concentrations of phthalates ranged from below the detection limit ($< 5 \mu\text{g/kg}$) for dimethyl phthalate to $542 \mu\text{g/kg}$ for di-n-butyl phthalate.

Table 5. Summary of Physical/Chemical Analysis of Slip 3 Project Sediments and a Comparison to Published ER-L and ER-M Sediment Quality Values, and TTLC Regulatory Levels¹

Analyte	ER-L	ER-M	TTLC	Area PE 1 Top Composite			Area PE 1 Bottom Composite			Area PE 2 Top Composite			Area PE 2 Bottom Composite		
Physical Analyses															
Gravel (%)	-	-	-	1.51			0.28			6.56			0.003		
Sand (%)	-	-	-	12.4			47.2			32.8			66.7		
Silt (%)	-	-	-	57.8			42.1			40.5			27.4		
Clay (%)	-	-	-	28.3			10.5			20.1			5.91		
Solids, Total (%)	-	-	-	69.1			69.6			66.3			74.6		
Soil Classification	-	-	-	CL			SM			CL			SM		
Atterberg Limits	-	-	-	LL	PL	PI	LL	PL	PI	LL	PL	PI	LL	PL	PI
				48	26	22	--	NP	--	40	22	18	--	NP	--
General Chemistry															
TOC (%)	-	-	-	1.08			0.39			1.51			0.38		
Specific Gravity	-	-	-	1.54			1.76			1.70			1.82		
Ammonia (mg/kg Wet Weight)	-	-	-	61.2			61.9			41.7			35.4		
Dissolved Sulfide (mg/ kg)	-	-	-	1.09			1.24			0.67			1.72		
Total Sulfide (mg/kg)	-	-	-	149			70.7			177			3.55		
Oil and Grease (%)	-	-	-	<2			<2			<2			<2		
TRPH (%)	-	-	-	<0.10			<0.10			<0.10			<0.10		
Metals (mg/kg)															
Arsenic (As)	8.2	70	500	10.6			6.07			9.20			3.70		
Cadmium (Cd)	1.2	9.6	1200	0.70			0.37			0.77			0.08		
Chromium (Cr)	81.0	370	-	44.3			25.1			35.4			17.9		
Copper (Cu)	34.0	270	2500	61.8			29.3			63.8			19.4		
Lead (Pb)	46.7	218	1000	33.6			15.7			38.1			5.04		
Mercury (Hg)	0.15	0.71	20	0.30			0.14			0.31			0.06		
Nickel (Ni)	20.9	51.6	2000	25.3			18.3			22.7			14.7		
Selenium (Se)	-	-	100	0.48			0.26			0.34			<0.025		
Silver (Ag)	1.0	3.7	500	0.15			0.13			0.13			<0.025		
Zinc (Zn)	150.0	410	5000	118			69.6			110			45.1		
PCBs (mg/kg)															
PCB018	-	-	-	<1			<1			<1			<1		
PCB028	-	-	-	<1			<1			<1			<1		
PCB031	-	-	-	<1			<1			<1			<1		
PCB033	-	-	-	<1			<1			<1			<1		
PCB037	-	-	-	<1			<1			<1			<1		
PCB044	-	-	-	<1			<1			<1			<1		
PCB049	-	-	-	<1			<1			<1			<1		
PCB052	-	-	-	<1			<1			<1			<1		
PCB066	-	-	-	<1			<1			3.20J			<1		
PCB070	-	-	-	<1			<1			3.30J			<1		
PCB074	-	-	-	<1			<1			2J			<1		

Analyte	ER-L	ER-M	TTL	Area PE 1 Top Composite	Area PE 1 Bottom Composite	Area PE 2 Top Composite	Area PE 2 Bottom Composite
PCB077	-	-	-	<1	<1	<1	<1
PCB081	-	-	-	<1	<1	<1	<1
PCB087	-	-	-	<1	<1	<1	<1
PCB095	-	-	-	<1	<1	3.10J	<1
PCB097	-	-	-	<1	<1	<1	<1
PCB099	-	-	-	<1	<1	2.5J	<1
PCB101	-	-	-	2.70J	<1	3.40J	<1
PCB105	-	-	-	<1	<1	<1	<1
PCB110	-	-	-	2.70J	<1	3.70J	<1
PCB114	-	-	-	<1	<1	<1	<1
PCB118	-	-	-	<1	<1	2.80J	<1
PCB119	-	-	-	<1	<1	<1	<1
PCB123	-	-	-	<1	<1	<1	<1
PCB126	-	-	-	<1	<1	<1	<1
PCB128+167	-	-	-	<1	<1	<1	<1
PCB138	-	-	-	4.40J	1.80J	5.70	<1
PCB141	-	-	-	<1	<1	<1	<1
PCB149	-	-	-	2.90J	1.30J	3.5J	<1
PCB151	-	-	-	<1	<1	<1	<1
PCB153	-	-	-	4.90J	2.30J	5.30	<1
PCB156	-	-	-	<1	<1	<1	<1
PCB157	-	-	-	<1	<1	<1	<1
PCB158	-	-	-	<1	<1	1.40J	<1
PCB168+132	-	-	-	<1	<1	<1	<1
PCB169	-	-	-	<1	<1	<1	<1
PCB170	-	-	-	<1	1.40J	<1	<1
PCB177	-	-	-	<1	<1	<1	<1
PCB180	-	-	-	4.30J	1.5J	5.20	<1
PCB183	-	-	-	1.60J	<1	<1	<1
PCB187	-	-	-	2.20J	<1	2J	<1
PCB189	-	-	-	<1	<1	<1	<1
PCB194	-	-	-	<1	<1	<1	<1
PCB200	-	-	-	<1	<1	<1	<1
PCB201	-	-	-	<1	<1	<1	<1
PCB206	-	-	-	<1	<1	<1	<1
Total PCBs	22.7	180	50000	25.7	8.3	47.1	0.0
Aroclors (mg/kg)							
Aroclor-1016	-	-	-	<10	<10	<10	<10
Aroclor-1221	-	-	-	<10	<10	<10	<10
Aroclor-1232	-	-	-	<10	<10	<10	<10
Aroclor-1242	-	-	-	<10	<10	<10	<10
Aroclor-1248	-	-	-	<10	<10	<10	<10
Aroclor-1254	-	-	-	22	<10	30.2	<10
Aroclor-1260	-	-	-	<10	<10	<10	<10
Pesticides (mg/kg)							
2,4'-DDD	-	-	1000	<1	<1	<1	<1

Analyte	ER-L	ER-M	TTL	Area PE 1 Top Composite	Area PE 1 Bottom Composite	Area PE 2 Top Composite	Area PE 2 Bottom Composite
2,4'-DDE	-	-	1000	2.80J	<1	5.6	<1
2,4'-DDT	-	-	1000	<1	<1	<1	<1
4,4'-DDD	2.00	20.00	1000	<1	<1	2.30J	<1
4,4'-DDE	2.20	27.00	1000	14.6	<1	15	<1
4,4'-DDT	1.00	7.00	1000	<1	<1	<1	<1
Total Detectable DDTs	1.60	46.1		17.4	0	22.9	0.0
Aldrin	-	-	1400	<1	<1	<1	<1
BHC-alpha	-	-	-	<1	<1	<1	<1
BHC-beta	-	-	-	<1	<1	<1	<1
BHC-delta	-	-	-	<1	<1	<1	<1
BHC-gamma	-	-	4000	<1	<1	<1	<1
Chlordane-alpha	-	-	2500	<1	<1	<1	<1
Chlordane-gamma	-	-	2500	<1	<1	<1	<1
trans-Nonachlor	-	-	4700	<1	<1	<1	<1
cis-Nonachlor	-	-	-	<1	<1	<1	<1
Oxychlordane	-	-	-	<1	<1	<1	<1
Total Chlordane	0.5	6	2500	0	0	0	0
Dieldrin	0.02	8.00	8000	<1	<1	<1	<1
Endosulfan Sulfate	-	-	-	<1	<1	<1	<1
Endosulfan I	-	-	-	<1	<1	<1	<1
Endosulfan II	-	-	-	<1	<1	<1	<1
Endrin	-	-	200	<1	<1	<1	<1
Endrin Aldehyde	-	-	-	<1	<1	<1	<1
Endrin Ketone	-	-	-	<1	<1	<1	<1
Heptachlor	-	-	4700	<1	<1	<1	<1
Heptachlor Epoxide	-	-	-	<1	<1	<1	<1
Methoxychlor	-	-	100000	<1	<1	<1	<1
Mirex	-	-	-	<1	<1	<1	<1
Toxaphene	-	-	5000	<10	<10	<10	<10
Organotins (mg/kg)							
Dibutyltin	-	-	-	7.6	<1	8.6	<1
Monobutyltin	-	-	-	<1	<1	<1	<1
Tetrabutyltin	-	-	-	<1	<1	<1	<1
Tributyltin	-	-	-	56.7	<1	59.5	<1
PAHs (mg/kg)							
1-Methylnaphthalene			-	2.5J	<1	10.3	<1
1-Methylphenanthrene			-	7.10	2.80J	26.2	1J
2,3,5-Trimethylnaphthalene			-	2.90J	2.60J	5.50	<1
2,6-Dimethylnaphthalene			-	3.80J	<1	16.2	<1
2-Methylnaphthalene	240	1500	-	4.5J	<1	31.2	1.20J
Acenaphthene	16	500	-	4.10J	<1	32.2	1J
Acenaphthylene	44	640	-	36.1	4.30J	35.8	2.1J
Anthracene	85	1100	-	63.8	5.80	124	4.5J
Benz[a]anthracene	261	1600	-	78.1	11.7	312	13.7
Benzo[a]pyrene	430	1600	-	180	17	485	18.9

Analyte	ER-L	ER-M	TTL	Area PE 1 Top Composite	Area PE 1 Bottom Composite	Area PE 2 Top Composite	Area PE 2 Bottom Composite
Benzo[b]fluoranthene	-	-	-	156	13	351	15
Benzo[e]pyrene	-	-	-	111	12.6	301	14
Benzo[g,h,i]perylene	-	-	-	76.2	12.1	220	9.80
Benzo[k]fluoranthene	-	-	-	174	14.4	402	16.8
Biphenyl	-	-	-	1.30J	<1	3.80J	<1
Chrysene	384	2800	-	148	18.1	504	21.4
Dibenz[a,h]anthracene	63	260	-	24.0	2.40J	85.2	3.10J
Dibenzothiophene	-	-	-	3J	<1	15.3	<1
Fluoranthene	600	5100	-	86.2	17.5	320	11.50
Fluorene	19	540	-	5	<1	17.5	<1
Indeno[1,2,3-c,d]pyrene	-	-	-	81.1	10	232	9.20
Naphthalene	160	2100	-	5.10	1.10J	23.9	1.10J
Perylene	-	-	-	41.5	6.70	92.7	4.80J
Phenanthrene	240	1500	-	35.9	4.40J	174	6.70
Pyrene	665	2600	-	204	38.6	416	15.7
Total LMW PAHs	552	3160	-	720.7	105.3	2121.7	84.3
Total HMW PAHs	1700	9600	-	150	17.1	438	19.2
Total PAHs	4022	44792	-	1534.8	195.1	4235.4	171.4
Phenols (mg/kg)							
2,4,6-Trichlorophenol	-	-	-	<50	<50	<50	<50
2,4-Dichlorophenol	-	-	-	<50	<50	<50	<50
2,4-Dimethylphenol	-	-	-	<100	<100	<100	<100
2,4-Dinitrophenol	-	-	-	<100	<100	<100	<100
2-Chlorophenol	-	-	-	<50	<50	<50	<50
4,6-Dinitro-2-Methylphenol	-	-	-	<100	<100	<100	<100
2-Nitrophenol	-	-	-	<100	<100	<100	<100
4-Chloro-3-Methylphenol	-	-	-	<100	<100	<100	<100
4-Nitrophenol	-	-	-	<100	<100	<100	<100
Pentachlorophenol	-	-	-	<50	<50	<50	<50
Phenol	-	-	-	<100	<100	<100	<100
Phthalates (mg/kg)							
bis(2-Ethylhexyl) Phthalate	-	-	-	70.6	39.1	79.7	27.7
Butylbenzyl Phthalate	-	-	-	10.6	5.98J	8.83J	<5
Diethyl Phthalate	-	-	-	31.2	23.4	26.0	23.0
Dimethyl Phthalate	-	-	-	<5	<5	<5	<5
Di-n-butyl Phthalate	-	-	-	640	790	737	542
Di-n-octyl Phthalate	-	-	-	<5	<5	<5	<5

¹ All values in dry weight except where noted

BOLD The measured concentration exceeds the analyte's respective ER-L value.

BOLD and Underlined The measured concentration exceeds the analyte's respective ER-M value.

< = Below the method detection limit indicated.

J = Analyte detected at a concentration below the reporting limit and above the method detection limit. Value is estimated.

LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; NP = non-plastic CL = Lean Clay SM = Silty Sands

HMW PAHs = high molecular weight PAHs; LMW PAHs = low molecular weight PAHs

3.2.2 Chemical Characteristics of Elutriates and Site Water

Results of physical and chemical analyses for project sediment elutriates and site water are presented in Table 6. Target detection limits are provided in the SAP (Weston 2006). The actual detection limits and raw data for the analyses are provided in Appendix C.

3.2.2.1 Area PE 1 Top

In Area PE 1 top layer sediment elutriates, several metals were detected, but none exceeded the daily maximum limiting concentrations, or water quality objectives for the protection of marine aquatic life. Metals concentrations also were below corresponding 6-month median limiting concentrations, or more conservative water quality objectives. Concentrations of heavy metals of concern ranged from below the detection limit for mercury (<0.01 $\mu\text{g/L}$) and silver (<0.02 $\mu\text{g/L}$) to 4.04 $\mu\text{g/L}$ for arsenic. PCB congeners, aroclor PCBs, organochlorine pesticides, organotins, and phenols were not detected in Area PE 1 top layer sediment elutriates. Several PAHs were detected and concentrations ranged from below detection limits for several PAHs to 31.4 ng/L for pyrene (no water quality objectives). The concentration of ammonia in Area PE 1 top layer elutriates (0.9 mg/L) also was below the daily maximum limiting concentration of 2.4 mg/L.

3.2.2.2 Area PE 1 Bottom

In Area PE 1 bottom layer sediment elutriates, several metals were detected, but none exceeded the daily maximum limiting concentrations, or water quality objectives for the protection of marine aquatic life. Metals concentrations also were below corresponding 6-month median limiting concentrations, or more conservative water quality objectives. Concentrations of heavy metals of concern ranged from below the detection limit for mercury (<0.01 $\mu\text{g/L}$) and silver (<0.02 $\mu\text{g/L}$) to 2.59 $\mu\text{g/L}$ for arsenic. PCB congeners, aroclor PCBs, organochlorine pesticides, organotins, and phenols were not detected in Area PE 1 bottom layer sediment elutriates. Several PAHs were detected and concentrations ranged from below detection limits for several PAHs to 44.2 ng/L for pyrene (no water quality objectives). The concentration of ammonia in Area PE 1 bottom layer elutriates (0.9 mg/L) also was below the daily maximum limiting concentration of 2.4 mg/L.

3.2.2.3 Area PE 2 Top

In Area PE 2 top layer sediment elutriates, several metals were detected, but none exceeded the daily maximum limiting concentrations, or water quality objectives for the protection of marine aquatic life. Metals concentrations also were below corresponding 6-month median limiting concentrations, or more conservative water quality objectives. Concentrations of heavy metals of concern ranged from below the detection limit for mercury (<0.01 $\mu\text{g/L}$) and silver (<0.02 $\mu\text{g/L}$) to 2.36 $\mu\text{g/L}$ for arsenic. PCB congeners, aroclor PCBs, organochlorine pesticides, organotins, and phenols were not detected in Area PE 2 top layer sediment elutriates. Several PAHs were detected and concentrations ranged from below detection limits for several PAHs to 23.8 ng/L for benzo(b)fluoranthene (no water quality objectives). The concentration of ammonia in Area PE 2 top layer elutriates (0.8 mg/L) also was below the daily maximum limiting concentration of 2.4 mg/L.

3.2.2.4 Area PE 2 Bottom

In Area PE 2 bottom layer sediment elutriates, several metals were detected, but none exceeded the daily maximum limiting concentrations, or water quality objectives for the protection of marine aquatic life. Metals concentrations also were below corresponding 6-month median limiting concentrations, or more conservative water quality objectives. Concentrations of heavy metals of concern ranged from below the detection limit for mercury (<0.01 $\mu\text{g/L}$) and silver (<0.02 $\mu\text{g/L}$) to 5.78 $\mu\text{g/L}$ for arsenic. PCB congeners, aroclor PCBs, organochlorine pesticides, organotins, and phenols were not detected in Area PE 2 bottom

layer sediment elutriates. Several PAHs were detected and concentrations ranged from below detection limits for several PAHs to 43.0 ng/L for pyrene (no water quality objectives). The concentration of ammonia in Area PE 2 bottom layer elutriates (0.3 mg/L) also was below the daily maximum and 6-month median limiting concentrations of 2.4 mg/L and 0.6 mg/L, respectively.

3.2.2.5 Pier E Site Water

In site water, several metals were detected, but none exceeded the daily maximum limiting concentrations, or water quality objectives for the protection of marine aquatic life. Metals concentrations also were below corresponding 6-month median limiting concentrations, or more conservative water quality objectives. Concentrations of heavy metals of concern ranged from below the detection limit for mercury (<0.01 $\mu\text{g/L}$) and silver (<0.02 $\mu\text{g/L}$) to 3.96 $\mu\text{g/L}$ for zinc. PCB congeners, aroclor PCBs, organochlorine pesticides, organotins, phenols, and ammonia were not detected in site water. Several PAHs were detected and concentrations ranged from below detection limits to 33.8 ng/L for phenanthrene (no water quality objectives).

Table 6. Summary of Chemical Analysis of Sediment Elutriates and Site Water From Slip 3 and a Comparison to Water Quality Objectives in the California Ocean Plan.

Analyte	Water Quality Objective ²	PE 1 Top Elutriate	PE 1 Bottom Elutriate	PE 2 Top Elutriate	PE 2 Bottom Elutriate	Pier E Site Water
General Chemistry						
Ammonia (mg/L)	2.4	0.9	0.9	0.8	0.3	<0.01
Metals (µg/L)						
Arsenic (As)	32	4.04	2.59	2.36	5.78	1.22
Cadmium (Cd)	4	0.02	0.03	0.02	0.01	0.03
Chromium (Cr)	8	0.52	0.38	0.51	0.75	0.96
Copper (Cu)	12	0.60	0.66	0.6	0.58	1.86
Lead (Pb)	8	0.08	0.14	0.09	0.06	0.44
Mercury (Hg)	0.16	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel (Ni)	20	1.22	2.35	1.43	0.91	0.55
Selenium (Se)	60	0.22	0.08	0.17	0.07	0.02
Silver (Ag)	2.8	<0.02	<0.02	<0.02	<0.02	<0.02
Zinc (Zn)	80	2	1.23	0.36	0.41	3.96
PCBs (ng/L)						
PCB018	--	<1	<1	<1	<1	<1
PCB028	--	<1	<1	<1	<1	<1
PCB031	--	<1	<1	<1	<1	<1
PCB033	--	<1	<1	<1	<1	<1
PCB037	--	<1	<1	<1	<1	<1
PCB044	--	<1	<1	<1	<1	<1
PCB049	--	<1	<1	<1	<1	<1
PCB052	--	<1	<1	<1	<1	<1
PCB066	--	<1	<1	<1	<1	<1
PCB070	--	<1	<1	<1	<1	<1
PCB074	--	<1	<1	<1	<1	<1
PCB077	--	<1	<1	<1	<1	<1
PCB081	--	<1	<1	<1	<1	<1
PCB087	--	<1	<1	<1	<1	<1
PCB095	--	<1	<1	<1	<1	<1
PCB097	--	<1	<1	<1	<1	<1
PCB099	--	<1	<1	<1	<1	<1
PCB101	--	<1	<1	<1	<1	<1
PCB105	--	<1	<1	<1	<1	<1
PCB110	--	<1	<1	<1	<1	<1
PCB114	--	<1	<1	<1	<1	<1
PCB118	--	<1	<1	<1	<1	<1
PCB119	--	<1	<1	<1	<1	<1
PCB123	--	<1	<1	<1	<1	<1
PCB126	--	<1	<1	<1	<1	<1
PCB128+167	--	<1	<1	<1	<1	<1
PCB138	--	<1	<1	<1	<1	<1
PCB141	--	<1	<1	<1	<1	<1
PCB149	--	<1	<1	<1	<1	<1
PCB151	--	<1	<1	<1	<1	<1

Analyte	Water Quality Objective ²	PE 1 Top Elutriate	PE 1 Bottom Elutriate	PE 2 Top Elutriate	PE 2 Bottom Elutriate	Pier E Site Water
PCB153	--	<1	<1	<1	<1	<1
PCB156	--	<1	<1	<1	<1	<1
PCB157	--	<1	<1	<1	<1	<1
PCB158	--	<1	<1	<1	<1	<1
PCB168+132	--	<1	<1	<1	<1	<1
PCB169	--	<1	<1	<1	<1	<1
PCB170	--	<1	<1	<1	<1	<1
PCB177	--	<1	<1	<1	<1	<1
PCB180	--	<1	<1	<1	<1	<1
PCB183	--	<1	<1	<1	<1	<1
PCB187	--	<1	<1	<1	<1	<1
PCB189	--	<1	<1	<1	<1	<1
PCB194	--	<1	<1	<1	<1	<1
PCB200	--	<1	<1	<1	<1	<1
PCB201	--	<1	<1	<1	<1	<1
PCB206	--	<1	<1	<1	<1	<1
Total PCBs	--	0	0	0	0	0
Aroclors (ng/L)						
Aroclor-1016	--	<10	<10	<10	<10	<10
Aroclor-1221	--	<10	<10	<10	<10	<10
Aroclor-1232	--	<10	<10	<10	<10	<10
Aroclor-1242	--	<10	<10	<10	<10	<10
Aroclor-1248	--	<10	<10	<10	<10	<10
Aroclor-1254	--	<10	<10	<10	<10	<10
Aroclor-1260	--	<10	<10	<10	<10	<10
Pesticides (ng/L)						
2,4'-DDD	--	<1	<1	<1	<1	<1
2,4'-DDE	--	<1	<1	<1	<1	<1
2,4'-DDT	--	<1	<1	<1	<1	<1
4,4'-DDD	--	<1	<1	<1	<1	<1
4,4'-DDE	--	<1	<1	<1	<1	<1
4,4'-DDT	--	<1	<1	<1	<1	<1
Total Detectable DDTs	--	0.00	0.00	0.00	0.00	0.00
Aldrin	--	<1	<1	<1	<1	<1
BHC-alpha	--	<1	<1	<1	<1	<1
BHC-beta	--	<1	<1	<1	<1	<1
BHC-delta	--	<1	<1	<1	<1	<1
BHC-gamma	--	<1	<1	<1	<1	<1
Total BHC	8	0.00	0.00	0.00	0.00	0.00
Chlordane-alpha	--	<1	<1	<1	<1	<1
Chlordane-gamma	--	<1	<1	<1	<1	<1
cis-Nonachlor	--	<1	<1	<1	<1	<1
trans-Nonachlor	--	<1	<1	<1	<1	<1
Oxychlordane	--	<1	<1	<1	<1	<1
Total Chlordane	--	0.00	0.00	0.00	0.00	0.00
Dieldrin	--	<1	<1	<1	<1	<1
Endosulfan Sulfate	--	<1	<1	<1	<1	<1

Analyte	Water Quality Objective ²	PE 1 Top Elutriate	PE 1 Bottom Elutriate	PE 2 Top Elutriate	PE 2 Bottom Elutriate	Pier E Site Water
Endosulfan I	--	<1	<1	<1	<1	<1
Endosulfan II	--	<1	<1	<1	<1	<1
Endosulfans	18	0.00	0.00	0.00	0.00	0.00
Endrin	--	<1	<1	<1	<1	<1
Endrin Aldehyde	--	<1	<1	<1	<1	
Endrin Ketone	--	<1	<1	<1	<1	<1
Total Endrins	4	0.00	0.00	0.00	0.00	0.00
Heptachlor	--	<1	<1	<1	<1	<1
Heptachlor Epoxide	--	<1	<1	<1	<1	<1
Methoxychlor	--	<1	<1	<1	<1	<1
Mirex	--	<1	<1	<1	<1	<1
Toxaphene	--	<10	<10	<10	<10	<10
Organotins (ng/L)						
Dibutyltin	--	<1	<1	<1	<1	<1
Monobutyltin	--	<1	<1	<1	<1	<1
Tetrabutyltin	--	<1	<1	<1	<1	<1
Tributyltin	--	<1	<1	<1	<1	<1
PAHs (ng/L)						
1-Methylnaphthalene	--	5.29	<1	<1	4.45J	11.3
1-Methylphenanthrene	--	<1	<1	<1	<1	<1
2,3,5-Trimethylnaphthalene	--	<1	<1	<1	<1	<1
2,6-Dimethylnaphthalene	--	<1	<1	<1	<1	<1
2-Methylnaphthalene	--	5.24	<1	6.07	3.94J	13.3
Acenaphthene	--	28	20.9	<1	27	25.2
Acenaphthylene	--	2.28J	5.47	3.87J	<1	<1
Anthracene	--	<1	<1	13.6	<1	7.70J
Benz[a]anthracene	--	<1	<1	<1	<1	<1
Benzo[a]pyrene	--	<1	<1	15.0	<1	<1
Benzo[b]fluoranthene	--	<1	<1	23.8	<1	<1
Benzo[e]pyrene	--	<1	<1	11.9	<1	<1
Benzo[g,h,i]perylene	--	10.5	<1	<1	<1	25.3
Benzo[k]fluoranthene	--	<1	<1	22.9	<1	<1
Biphenyl	--	5.48	4.97J	5.52	4.91J	14.9
Chrysene	--	<1	6.26	<1	<1	<1
Dibenz[a,h]anthracene	--	<1	<1	<1	<1	<1
Dibenzothiophene	--	<1	<1	<1	<1	<1
Fluoranthene	--	<1	27.6	<1	<1	29.2
Fluorene	--	<1	<1	<1	<1	15.3
Indeno[1,2,3-c,d]pyrene	--	14.1	<1	<1	<1	22.0
Naphthalene	--	10.5	8.97	19	10.1	11.8
Perylene	--	<1	<1	<1	<1	<1
Phenanthrene	--	4.13J	<1	<1	<1	33.8
Pyrene	--	31.4	44.2	10.4	3.51J	15.8
Total LMW PAHs	--	50.2	37.3	44.0	43.0	107.1
Total HMW PAHs	--	33.9	79.5	27.4	6.0	47.0
Total PAHs	--	116.9	118.4	132.1	53.9	225.6

Analyte	Water Quality Objective ²	PE 1 Top Elutriate	PE 1 Bottom Elutriate	PE 2 Top Elutriate	PE 2 Bottom Elutriate	Pier E Site Water
Phenols (ng/L)						
2,4,6-Trichlorophenol	4000	<50	<50	<50	<50	<50
2,4-Dichlorophenol	4000	<50	<50	<50	<50	<50
2,4-Dimethylphenol	120000	<100	<100	<100	<100	<100
2,4-Dinitrophenol	120000	<100	<100	<100	<100	<100
2-Chlorophenol	4000	<50	<50	<50	<50	<50
4,6-Dinitro-2-Methylphenol	120000	<100	<100	<100	<100	<100
2-Nitrophenol	120000	<100	<100	<100	<100	<100
4-Chloro-3-Methylphenol	4000	<100	<100	<100	<100	<100
4-Nitrophenol	120000	<100	<100	<100	<100	<100
Pentachlorophenol	4000	<50	<50	<50	<50	<50
Phenol	120000	<100	<100	<100	<100	<100

²Comparison was to the daily maximum limiting concentration (California Ocean Plan 2006)

BOLD The measured concentration exceeds the analyte's respective water quality objective

< = Below the method detection limit indicated.

HMW PAHs = high molecular weight PAHs; LMW PAHs = low molecular weight PAHs

3.3 Quality Control Results

3.3.1 Physical Analysis of Sediments

All physical analyses met QA/QC criteria specified by ASTM or USEPA guidelines for the measurement of grain size, specific gravity, total solids, TOC, and Atterberg limits.

3.3.2 Chemical Analysis

Method reporting limits (MRLs) for target analytes were greater than or equal to method detection limits (MDLs) and above instrument detection limits as described by USEPA SW-846 protocol. MDLs and MRLs are listed in Weston's SAP.

3.3.2.1 Sediments

All chemical analyses met QA/QC criteria with only a few exceptions. Laboratory contamination was controlled through the analysis of procedural blanks on a minimum frequency of 1 per batch and procedural blanks were 10 times below the MDL, with the exception of phthalates. The procedural blanks demonstrated detectable concentrations of phthalates including bis (2-ethylhexyl)phthalate, di-n-butyl phthalate, and diethyl phthalate, likely due to contamination resulting from analytical processes or equipment, a problem frequently observed with phthalate analyses.

Accuracy of the project data was indicated by analysis of matrix spikes, surrogate spikes, certified reference materials, and/or laboratory control materials on a minimum frequency of one per batch. For 95% of the target compounds greater than 10 times the MDL, measured concentrations were within the specified acceptance limits.

Precision of the project data was determined by analysis of duplicate matrix spikes, blank spikes, and/or duplicate test sample analysis on a minimum frequency of one per batch. All laboratory control sample analyses met the percent recovery and relative percent difference (RPD) criteria established for the appropriate methods for all chemicals with the exception of total sulfides, bis(2-ethylhexyl)phthalate, tributyltin, and several PAHs. For total sulfides, the spike or surrogate compound recovery was out of control due to matrix interference. The associated method blank spike or surrogate compound was in control and therefore the sample data was reported without further clarification. For tributyltin, di-n-butyl phthalate, and the PAHs benzo(a)pyrene, fluoranthene, and pyrene, the spike recovery and RPD control limits do not apply because the parameter concentration in the sample exceeded the spike concentration.

Based on QA/QC results, the actual detectable concentrations of the three phthalates (bis (2-ethylhexyl)phthalate, di-n-butyl phthalate, and diethyl phthalate) in Slip 3 sediment samples should be interpreted with caution, especially for samples demonstrating low concentrations of these chemicals.

3.3.2.2 Elutriates and Site Water

All chemical analyses met QA/QC criteria with only one exception. Laboratory contamination was controlled through the analysis of procedural blanks on a minimum frequency of 1 per batch and procedural blanks were 10 times below the MDL. The procedural blanks demonstrated no detectable concentrations of any chemicals except mercury at a concentration of 0.001 µg/L. Because this concentration of mercury is far below the MDL and mercury was not detected in any sediment elutriates or site water samples, mercury in the blank was not considered problematic.

Accuracy of the project data was indicated by analysis of matrix spikes, surrogate spikes, certified reference materials, and/or laboratory control materials on a minimum frequency of one per batch. For

95% of the target compounds greater than 10 times the MDL, measured concentrations were within the specified acceptance limits.

Precision of the project data was determined by analysis of duplicate matrix spikes, blank spikes, and/or duplicate test sample analysis on a minimum frequency of one per batch. All laboratory control sample analyses met the percent recovery and RPD criteria established for the appropriate methods for all chemicals. For selenium in site water, the RPD was 48% and was above the established criteria.

Based on QA/QC results, the actual detectable concentrations of selenium in Slip 3 sediment samples should be interpreted with caution, especially for samples demonstrating low concentrations of this trace metal.

4.0 CONCLUSIONS

- The top layer of sediment from Areas PE 1 and PE 2 was comprised of 86.1% and 60.6% fine-grained materials (clay and silt), respectively. The bottom layer of sediment from Areas PE 1 and PE 2 was comprised of 47.5% and 66.7% coarse-grained materials (gravel and sand), respectively.
- Concentrations of all chemicals analyzed in sediment from Areas PE 1 and PE 2 were relatively low. In the top layer of sediment from Areas PE 1 and PE 2, there were a few ER-L exceedances for metals, DDTs, total PCBs, and PAHs; however, all chemicals measured in sediment samples were below ER-M values. Other chemicals analyzed including chlorinated pesticides, phenols, organotins, and phthalates were found at relatively low concentrations. In the top layer of sediment from Areas PE 1 and PE 2, no phenols and no chlorinated pesticides except DDT derivatives were detected and organotins were below concentrations shown to cause toxicity to aquatic organisms (McGee *et al.* 1995, Austen and McEvoy 1997, Meader *et al.* 1997, Stronkhorst *et al.* 1999, Meador and Rice 2001, Hallers-Tjabbes *et al.* 2003). In the bottom layer of sediment from Areas PE 1 and PE 2, organochlorine pesticides and organotins were below the detection limit and no other chemicals including metals, PCBs, and PAHs exceeded ER-L values. For both bottom and top layers of sediment from Areas PE 1 and 2, phthalate concentrations in all sediment samples were below or near detection limits, or were at concentrations (i.e., bis(2-ethylhexyl)phthalate and di-n-butyl phthalate) indicative of laboratory contamination, discussed in the QA/QC results.
- Concentrations of all chemicals in elutriates of sediment from Areas PE 1 and PE 2 were low and none exceeded the daily maximum limiting concentrations or water quality objectives of the California Ocean Plan.
- Concentrations of chemicals in site water collected in Slip 3 were equivalent to those in sediment elutriates and none exceeded water quality objectives.
- In summary, chemical analyses of sediment and sediment elutriates in Slip 3 suggest that this material is suitable for use as fill in Slip 1.

5.0 REFERENCES

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